2.0 Source Assessment

Analyses were performed on historical water quality and streamflow data to determine critical flow conditions and relative loads to assess the impact of point and nonpoint sources on instream water quality. These analyses helped to assess nutrient and oxygen demanding sources in the Appoquinimink River watershed. Identification of critical flow conditions was an important step in determining the methodology used for TMDL development.

2.1 Data Sources

A wide range of information was reviewed for the Appoquinimink River watershed. The categories of data examined include physiographic data describing physical conditions of the watershed, environmental monitoring data identifying potential pollutant sources and contributions to the river and its tributaries, hydrologic flow data, and water quality monitoring data. Table 2-1 summarizes the various data types and data sources reviewed and collected.

Table 2-1. Sources of Data for the Appoquinimink River basin.

Data Category	Description	Data Source(s)
Watershed Physiographic Data	Land Use (National Land Cover Data)	USGS - MRLC
	Stream Reach Coverage (RF 1 and 3, and NHD)	USGS, US EPA BASINS
	Digital Elevation Model (30 meter resolution)	USGS - National Elevation Dataset (NED)
	Soils	NRCS/USGS STASGO
	Weather Information	National Climatic Data Center, National Weather Service
Hydrologic data	Stream Flow Data	USGS
Water Quality	Instream concentrations of nutrients and oxygen demanding substances as well as other parameters	EPA STORET

USGS - United States Geological Survey; BASINS - Better Assessment Science; STASGO - State Soil and Geographic Database; DNREC - Delaware Department of Natural Resources and Environmental Control; US EPA - United States Environmental Protection Agency; EPA STORET - STOrage and RETrieval System; RF 1 and 3 - Reach File 1 and Reach File 3; NHD - National Hydrography Dataset

Additionally, a number of technical reports describing past modeling efforts for the Appoquinimink River were reviewed. These include DNREC's *Technical Analysis for the Proposed Appoquinimink River TMDLs - October 2001* and Hydroqual's *The Appoquinimink River Watershed TMDL Model* (2001). The reader is referred to these reports for more detailed data summaries and analysis.

2.2 Nutrient and Oxygen Demanding Sources

A review of the historical data collected in the Appoquinimink River basin provided insight into the critical period for impact analysis. Once this condition was identified, the focus was directed to those sources having the most impact during such periods.

2.2.1 Identification of Critical Period

Nutrient and DO data have been collected by DNREC at multiple locations in the Appoquinimink River and its tributaries (see Figure 2-1). Concentrations of DO below the water quality standards have been observed at a number of stations, primarily during the summer months (i.e., June through September). Data and past modeling studies indicate that DO levels in the estuarine environment are influenced by contributions of nutrients and organic matter from the watershed (and ultimately the in-stream sediment) throughout the year. The impact from the loadings manifests itself during the summer period (DNREC, 2001). Therefore, the critical period can be influenced by a range of potential sources, including point and nonpoint sources.

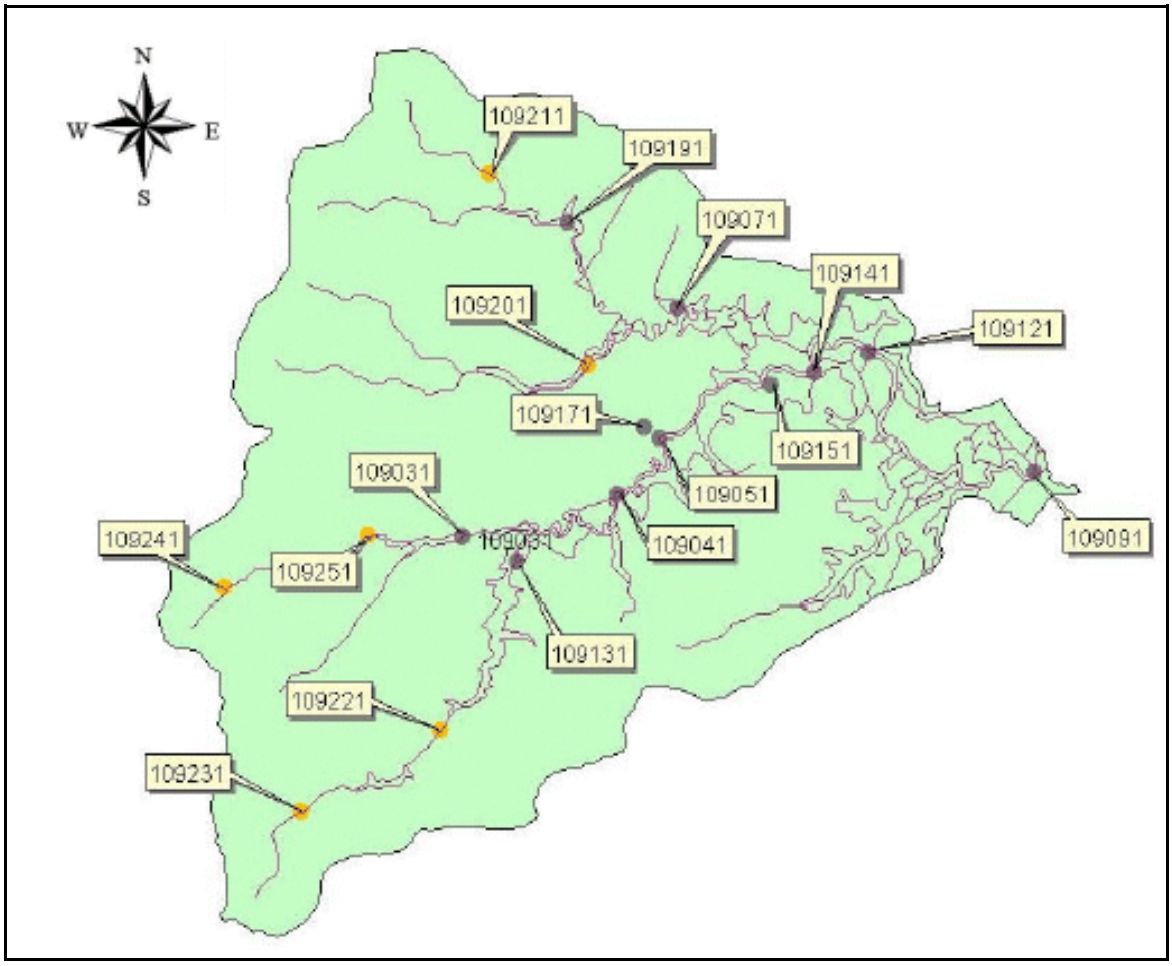

Figure 2-1. Monitoring stations in the Appoquinimink River basin.

2.2.2 Point Sources

Permitted point sources include discharges such as municipal waste water treatment plants, storm water systems, and industrial waste water facilities. The only non storm water point source discharger to the Appoquinimink River is the Middletown-Odessa-Townsend wastewater treatment plant (MOT WWTP, permit number DE0050547). The permitted and estimated characteristics of the MOT WWTP effluent are summarized in Table 2-2.

Table 2-2. Characteristics of MOT WWTP NPDES discharge (DE0050547).

Parameter	Permit Value	Estimated Value	Load
Flow	0.5 mgd		-
CBOD-5 day	34.8 lbs/day		34.8 lbs/day
Total Kjeldahl Nitrogen (TKN)	3,796 lbs/year		10.4 lbs/day
Total Phosphorus (TP)	2.1 lbs/day		2.1 lbs/day
Dissolved Oxygen (DO)		0.695 mg/L	2.9 lbs/day

EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all storm water discharges from separate storm sewer systems (MS4s). Implementation of these regulations are phased such that large and medium sized municipalities were required to obtain storm water permit coverage in 1990 and small municipalities by March 2003. New Castle County has a general storm water permit which includes the municipalities of Middletown, Odessa, and Townsend. These municipalities cover less than 3 percent of the Appoquinimink watershed, but contain most of the watershed's population (4,500 people). The population is expected to expand within the near future. Although the watershed's economy is essentially agrarian, some light industry does exist in Middletown. The MS4 permit for New Castle county covers the major municipalities within the County and the Delaware Department of Transportation. The storm water loadings from the land segments covered by this permit required a waste load allocation (WLA).

2.2.3 Nonpoint Sources

In addition to point sources, nonpoint sources may also contribute to water quality impairments in the Appoquinimink watershed. Nonpoint sources represent contributions from diffuse, non-permitted sources. Typically, nonpoint sources are precipitation driven and occur as overland flow that carries pollutants into streams. They can impact a waterbody directly, e.g. through elevated concentrations during storm events and indirectly, e.g. through contribution to bottom sediments and ultimately sediment oxygen demand (SOD).

Land use information from the USGS Multi-Resolution Land Characterization (MRLC) completed in 1992 was available for the Appoquinimink watershed region and was used to evaluate potential nonpoint sources (as well as diffuse sources covered under the storm water permits). Landuse data for 2002 was obtained and used to supplement analysis of the 1992 data. Land use information for the Appoquinimink watershed is summarized in Table 2-3 (for both 1992 and 2002). The 1992 land use distribution for the Appoquinimink River watershed is shown in Figure 2-2.

Table 2-3. Landuse in the Appoquinimink River basin.

Landuse	1992		2002	
	mi^2	%	mi^2	%
Open Water	**1.47**	**3.19**	**1.83**	**3.97**
Low Intensity Residential	**0.85**	**1.84**	**6.06**	**13.13**
High Intensity Residential	**0.10**	**0.22**	**0.89**	**1.93**
High Intensity Commercial/ Industrial/ Transportation	**0.32**	**0.69**	**2.16**	**4.68**
Disturbed	**0.03**	**0.07**	**0.92**	**1.99**
Forest	**6.17**	**13.37**	**4.06**	**8.80**
Pasture/Hay	**8.41**	**18.22**	**1.60**	**3.47**
Row Crops	**23.53**	**50.99**	**23.74**	**51.44**
Other Grasses (Urban/recreational)	**0.01**	**0.02**	**0.34**	**0.74**
Wetlands	**5.26**	**11.40**	**4.55**	**9.86**
Total	**46.15**		**46.15**	

Note: The landuse datasets were obtained from different sources. Discrepancies between open water areas are attributable to a difference in the resolution of the datasets or possibly seasonal/hydrologic characteristics.

Based on the landuse data, it is clear that agricultural lands (row crops, in particular) cover a large portion of the watershed. Between 1992 and 2002, there was a significant increase in urban areas and a corresponding decrease in pasture/hay and forested areas. The 1997 Census of Agriculture identifies that the predominant crop types within New Castle County are soybeans, corn, and wheat. It also identifies that within the county, there are approximately 2,698 cattle and calves, 51 hogs and pigs, and 222 sheep and lambs (while chicken numbers are not available).

While a portion of the watershed is sewered, there are also areas that rely on septic systems for sewage disposal. Many of these areas fall outside denoted urban boundaries. Septic systems can contribute pollutants to waterbodies through a number of mechanisms usually associated with failure of the systems. Within New Castle County, there are approximately 12,000 septic tanks or cesspools (based on 1990 U.S. Census Bureau figures).

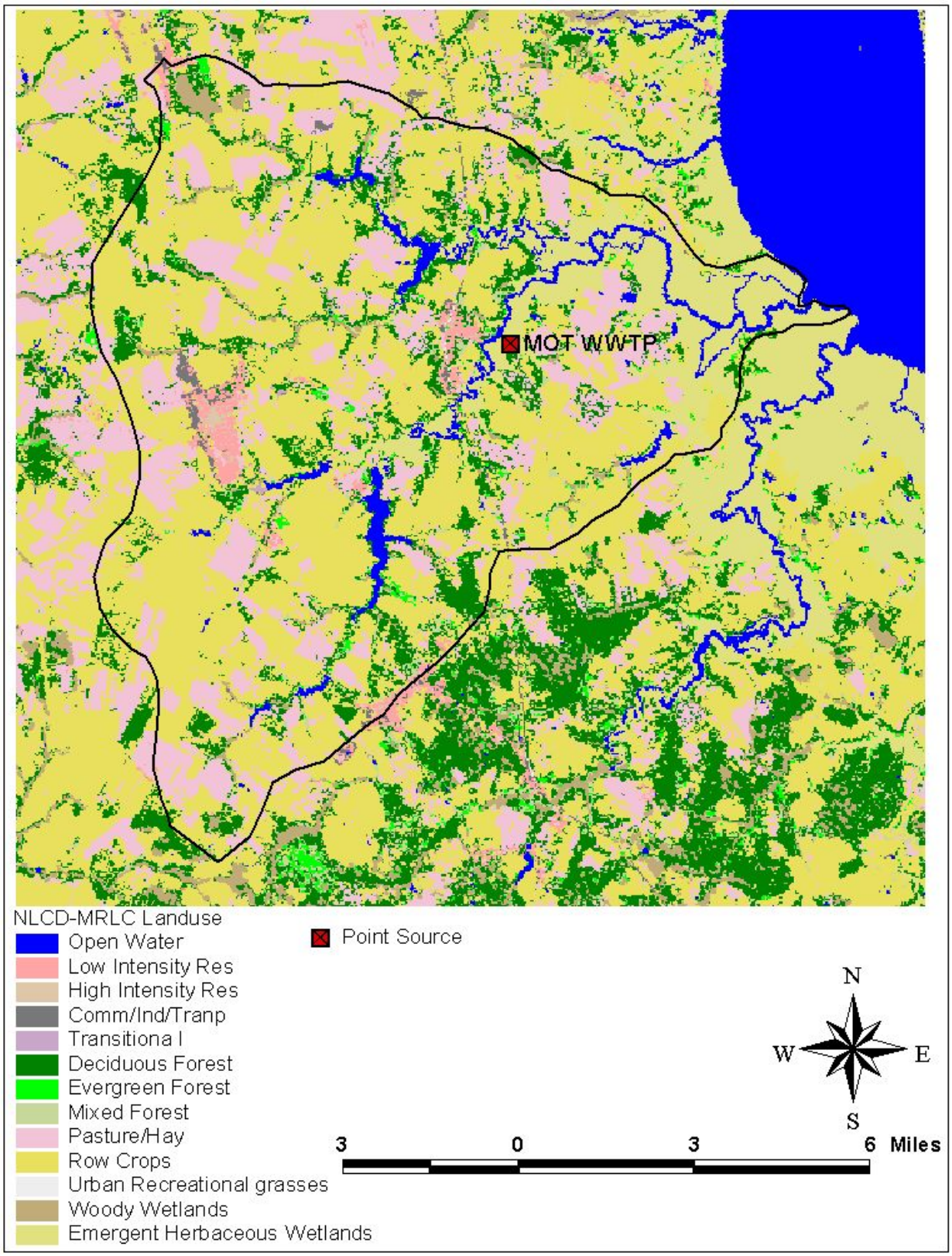

Figure 2-2. Land uses in the Appoquinimink River basin.